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(71) Applicant *(for all designated States except US)*: MAINETTI TECHNOLOGY LIMITED [GB/GB]; Haughhead, Hawick TD9 8LF (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: GIBSON, Arthur, Geoffrey [GB/GB]; 17 Avondale Court, Rectory Road, Gosforth, Newcastle–upon–Tyne NE3 1XQ (GB).

(74) Agent: VINSOME, Rex, Martin; Urquhart–Dykes & Lord, St. Nicholas Chambers, Amen Corner, Newcastle–upon–Tyne NE1 1PE (GB).

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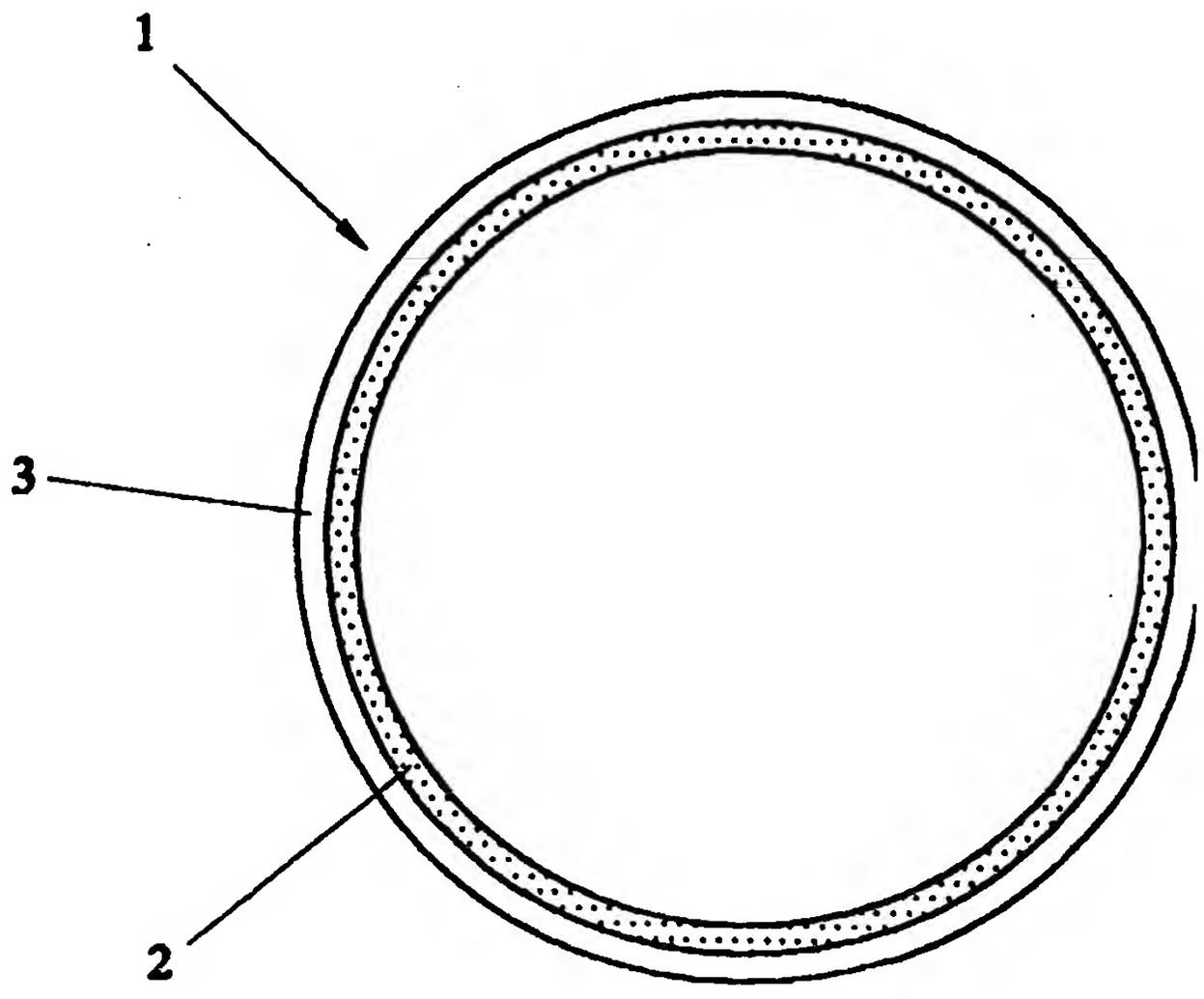
(54) Title: PIPE LINER AND PIPE LINING METHOD

(57) Abstract

A composite tube for lining a pipe comprises an inner polyethylene layer (2), a layer (4) of aluminium and an outer layer (6) of polyethylene. The tube is inserted into a pipe, and air or gas pressure within the tube is increased to expand the tube until its outer dimensions match the inner dimensions of the pipe and the aluminium layer is expanded beyond its elastic limit.



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PIPE LINER AND PIPE LINING METHOD

The present invention relates to a method of lining a pipe, and relates particularly, but not exclusively, to a method of lining a rigid undersea pipe for transporting water and/or hydrocarbon fuels and/or gas. The invention also relates to a liner for lining a pipe.

Pipes of various materials, such as concrete, clay, brick, mild steel, cast iron or lead often deteriorate with age and/or chemical attack. It is known to reline such pipes with plastics materials such as polyethylene rather than replace them.

Methods of relining pipes with polyethylene are known which include drawing down a polyethylene pipe to reduce its diameter, and inserting the polyethylene pipe into the pipe to be relined. After insertion, the polyethylene pipe is expanded to its original, larger diameter to provide a close interference fit inside the original pipe. Expansion of the polyethylene liner pipe can be achieved either by the natural recovery of the polyethylene pipe from its drawn down condition, or by the application of pressure and/or heat.

One particular application of such pipe relining methods is the field of subsea pipes, in which gas and/or liquids are pumped at high pressure through rigid steel pipes designed to withstand sea pressure. The pipes are lined with a polyethylene liner pipe to prevent corrosion of the steel pipes as a result of chemical attack by the gas and/or liquid to be transported in the pipe.

The above prior art method of lining such steel pipes suffers from the drawback that although an interference fit is achieved between the polyethylene liner pipe and the steel pipe, small voids remain between the polyethylene liner pipe and the steel outer pipe. With time, the liquid and/or gas being transported under high pressure migrates through the polyethylene liner pipe and occupies these voids between the polyethylene liner pipe and the steel outer pipe. Eventually, the pressure in the voids approaches the pressure of the gas or liquid being transported.

For operational reasons, it is sometimes necessary to stop pumping the liquid or gas, as a result of which the pressure of the liquid or gas in the pipe is significantly reduced. If liquid or gas is trapped in the voids between the liner pipe and outer pipe, it is then at higher pressure than the interior of the liner pipe and therefore causes the polyethylene liner pipe to collapse, as a result of whch the pipe is no longer serviceable and needs to be repaired or replaced.

One known attempt to solve this problem is to provide a thick polyethylene liner pipe, for example having a thickness as much as 10 mm. This reduces the rate at which the liquid or gas diffuses through the polyethylene to occupy the voids, and also provides additional resistance to collapse in the event that the external pressure (i.e. the pressure in the voids between the polyethylene liner pipe and the steel outer pipe) exceeds the internal pressure. However, the thick walled polyethylene liner pipes used reduce the internal diameter of the pipe, which in turn reduces the transport capacity of the pipe as a whole.

Preferred embodiments of the present invention seek to overcome the above disadvantages of the prior art.

Accordin to an aspect of the present invention, there is provided a method of lining a pipe, the method comprising:

inserting a liner into the pipe, the liner comprising a first elongate tube of plastics material and a second elongate tube of metal attached to said first tube and arranged radially outwardly thereof, wherein the external dimensions of said liner in a direction transverse to the longitudinal axis of the liner are smaller on insertion than the corresponding dimensions of the pipe; and

increasing fluid pressure in said first tube to cause said liner to expand such that the external dimensions of the liner correspond substantially to the internal dimensions of the pipe, wherein said second tube is expanded beyond its elastic limit.

The present invention is based on the unexpected discovery that a composite pipe comprising a tube of plastics material and a metal tube often expands much more uniformly than a tube of plastics material only. For example, it has been found that a polyethylene pipe does not expand uniformly under internal pressure, and ruptures at its weakest part, whereas composite pipes of polyethylene and metal expand more uniformly and can achieve diameters as much as 15% larger than their original diameter. The method of the present invention therefore provides the advantage that the liner pipe is less prone to rupture on expansion than the liner pipes of the prior art.

The method of the present invention also provides the advantage that the metal tube minimises migration of a gas or liquid to be transported through the liner to cause chemical attack of an outer pipe, and the metal layer stretched beyond its elastic limit can also hold the liner at its increased diameter. Because the metal tube minimises migration of the gas and/or liquid to be transported into voids between the liner and the outer pipe, this minimises the risk of collapse of the liner when the pipe is depressurised. Consequently, relatively thin walled liners can be used with the advantage that transport

capacity of the pipe as a whole is maximised, and material costs are reduced.

In a preferred embodiment, the step of increasing fluid pressure in the first tube comprises increasing the pressure of air within the tube.

The pipe and liner may be of substantially circular transverse cross-section.

In a preferred embodiment, the liner is flattened and coiled prior to said insertion step.

By flattening and coiling the liner prior to insertion, this provides the advantage of maximising the quantities of the liner which can be transported to an installation site. This in turn significantly reduces the need for joints in the liner.

The method is preferably a method of lining rigid undersea pipes.

In a preferred embodiment, the pipe is adapted to transport water and/or gas and/or hydrocarbon fuel.

The method preferably further comprises the step of pre-stressing said first tube during manufacture of said liner such that expansion of said liner reduces the stress in said first tube.

This provides the advantage of increasing the lifetime of the liner and reducing the risk of delamination between the first and second tubes.

According to another aspect of the invention, there is provided a liner for lining a pipe, the liner comprising a first elongate tube of plastics material and a second elongate tube of metal attached to said first tube and arranged radially

outwardly thereof, wherein the liner is adapted to be inserted into a pipe having external dimensions in a direction transverse to the longitudinal axis of the liner greater than the corresponding dimensions of the liner, and said liner is adapted to be expanded by increasing fluid pressure in said first tube such that the external dimensions of the liner correspond substantially to the internal dimensions of the pipe, and said second tube is expanded beyond its elastic limit.

The liner may further comprise a third tube of plastics material surrounding said second tube.

The second tube may include aluminium.

The first tube preferably includes polyethylene.

The first tube may include cross linked polyethylene.

Ibn a preferred embodiment, the pipe and liner are of substantially circular transverse cross-section.

The liner is preferably adapted to be flattened and coiled prior to insertion into the pipe.

A preferred embodiment of the invention will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 is a cross-sectional view of a polyethylene pipe and adhesive layer for use in manufacturing a liner pipe for use in a method embodying the present invention;

Figure 2 is a cross-sectional view of the polyethylene pipe and adhesive layer of Figure 1 having an aluminium tube attached thereto; and

Figure 3 is a cross-sectional view of a liner manufactured from the tubes of Figures 1 and 2 for use in a method embodying the present invention.

Referring in detail to Figure 1, a double tube 1 is produced by extrusion and comprises an inner layer 2 of polyethylene, preferably cross linked polyethylene, and an outer thin layer of adhesive 3. After extrusion, the tube 1 is allowed to cool.

Referring now to Figure 2, a sheet 4 of aluminium is then wrapped around the tube 1, and a seam of the aluminium sheet 4 continuously welded by means of a laser or other suitable welding device as will be familiar to persons skilled in the art. After welding and forming into a tube, the aluminium layer 4 is drawn down so that it is a tight fit over the double tube 1. The double tube 1 with the aluminium layer 4 thereon is then passed through an induction heater (not shown) which heats the aluminium layer 4, which in turn activates the adhesive layer 3 and causes the aluminium layer 4 and polyethylene layer 2 to be bonded together.

The composite polyethylene and aluminium tube is then passed through a second extrusion phase where a layer 5 of adhesive and an outer thicker layer 6 of polyethylene are laid over the outside of the aluminium layer 4, as shown in Figure 3.

In addition to the above steps, it has been found that it is also advantageous to draw down the double tube 1 of Figure 1 in diameter after extrusion, but before the aluminium layer 4 is wrapped around it and welded. As a result of this additional step, the inner polyethylene layer 2 is pre-stressed, but when the composite tube of Figure 3 is inflated, the inner polyethylene tube 2 can return to its natural unstressed state, as a result of which the lifetime of the tube is increased, and the risk of delamination between the inner polyethylene layer 2 and the aluminium layer 4 is minimised.

In order to reline a pipe such as a steel pipeline using the composite tube of Figure 3, the tube is inserted into a pipe (not shown) having an internal diameter slightly larger than the external diameter of the composite tube. The air pressure inside the tube is then increased, as a result of which the diameter of the tube increases until the external polyethylene tube 6 is an interference fit inside the pipeline (not shown). It has been found that the liner tube expands surprisingly uniformly during this process, with the result that the liner tube is much less prone to rupture than in the case of the prior art.

The aluminium layer 4 is stretched beyond its elastic limit, as a result of which the aluminium layer 4 holds the composite tube at this increased diameter. The inner polyethylene layer 2 then protects the outer pipe from chemical attack by a gas or liquid to be transported, while the aluminium layer 4 minimises diffusion of gas or liquid into voids between the outer polyethylene tube 6 and the outer pipe.

The reduced wall thickness of the composite tube of Figure 3 compared with prior art liner pipes enables the liner pipe (which may be as large as 200 mm in diameter) to be squashed flat and coiled for shipment to site prior to installation in the outer pipeline. This significantly reduces the need for joints in the liner pipe, which in turn simplifies manufacture.

It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only, and not in any limitative sense, and that various alternations and modifications are possible without departure from the scope of the invention as defined by the appended claims.

CLAIMS

1. A method of lining a pipe, the method comprising:

inserting a liner into the pipe, the liner comprising a first elongate tube of plastics material and a second elongate tube of metal attached to said first tube and arranged radially outwardly thereof, wherein the external dimensions of said liner in a direction transverse to the longitudinal axis of the liner are smaller on insertion than the corresponding dimensions of the pipe; and

increasing fluid pressure in said first tube to cause said liner to expand such that the external dimensions of the liner correspond substantially to the internal dimensions of the pipe, wherein said second tube is expanded beyond its elastic limit.

2. A method according to claim 1, further comprising the step of providing a third tube of plastics material surrounding said second tube.

3. A method according to claim 1 or 2, wherein the second tube includes aluminium.

4. A method according to any one of the preceding claims, wherein the first tube includes polyethylene.

5. A method according to claim 4, wherein the first tube includes cross linked polyethylene.

6. A method according to any one of the preceding claims, wherein the step of increasing fluid pressure in the first tube comprises increasing the pressure of air within the tube.

7. A method according to any one of the preceding claims, wherein the pipe and liner are of substantially circular transverse cross-section.

8. A method according to any one of the preceding claims, wherein the liner is flattened and coiled prior to said insertion step.

9. A method according to any one of the preceding claims, wherein the method is a method of lining rigid undersea pipes.

10. A method according to any one of the preceding claims, wherein the pipe is adapted to transport water and/or gas and/or hydrocarbon fuel.

11. A method according to any one of the preceding claims, further comprising the step of pre-stressing said first tube during manufacture of said liner such that expansion of said liner reduces the stress in said first tube.

12. A method of lining a pipe, the method substantially as hereinbefore described with reference to the accompanying drawings.

13. A liner for lining a pipe, the liner comprising a first elongate tube of plastics material and a second elongate tube of metal attached to said first tube and arranged radially outwardly thereof, wherein the liner is adapted to be inserted into a pipe having external dimensions in a direction transverse to the longitudinal axis of the liner greater than the corresponding dimensions of the liner, and said liner is adapted to be expanded by increasing fluid pressure in said first tube such that the external dimensions of the liner correspond substantially to the internal dimensions of the pipe, and said second tube is expanded beyond its elastic limit.

14. A liner according to claim 13, further comprising a third tube of plastics material surrounding said second tube.

15. A liner according to claim 13 or 14, wherein the second tube includes aluminium.

16. A liner according to any one of claims 13 to 15, wherein the first tube includes polyethylene.

17. A liner according to claim 16, wherein the first tube includes cross linked polyethylene.

18. A liner according to any one of claims 13 to 17, wherein the pipe and liner are of substantially circular transverse cross-section.

19. A liner according to any one of claims 13 to 18, wherein the liner is adapted to be flattened and coiled prior to insertion into the pipe.

20. A liner for lining a pipe, the liner substantially as hereinbefore described with reference to the accompanying drawings.

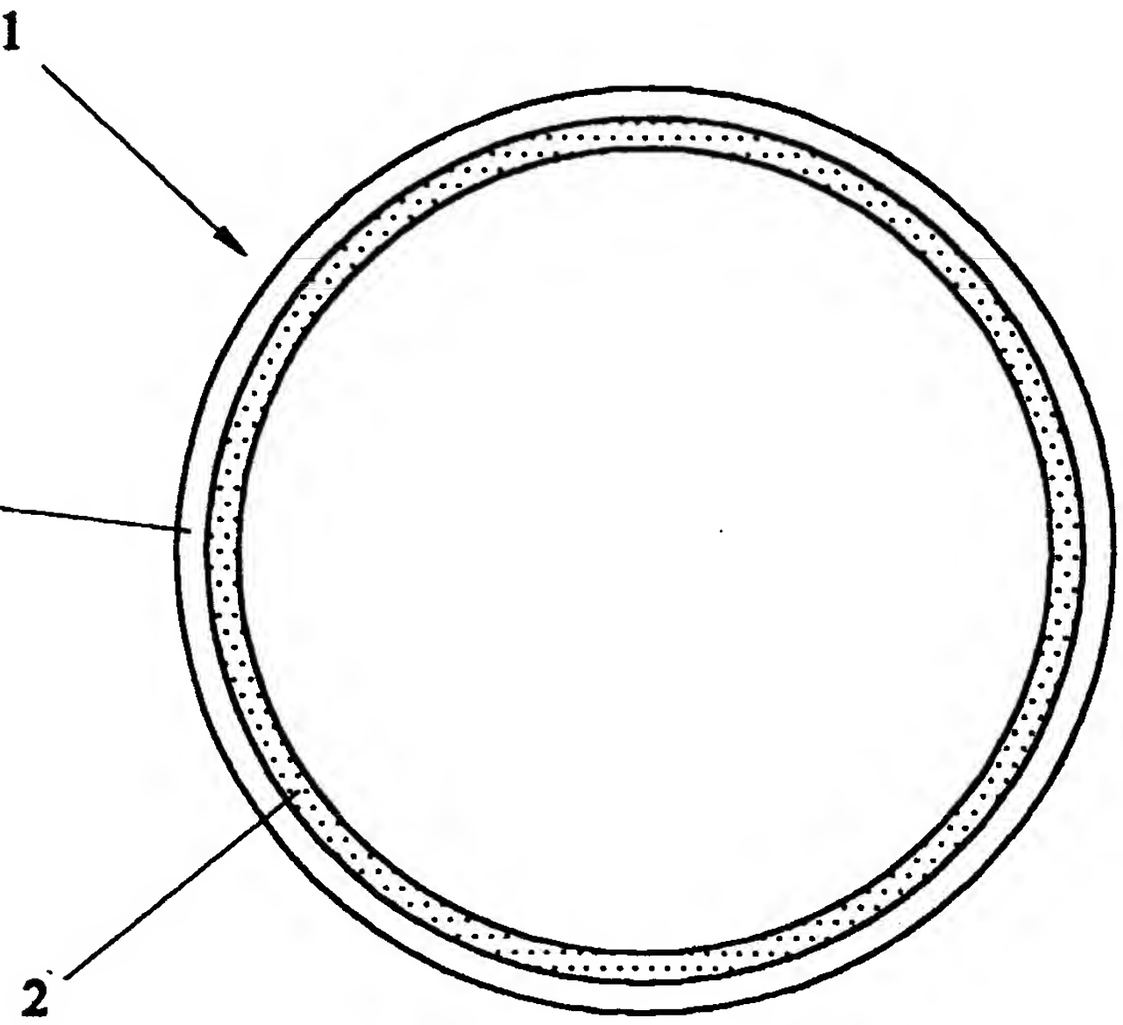

FIG. 1

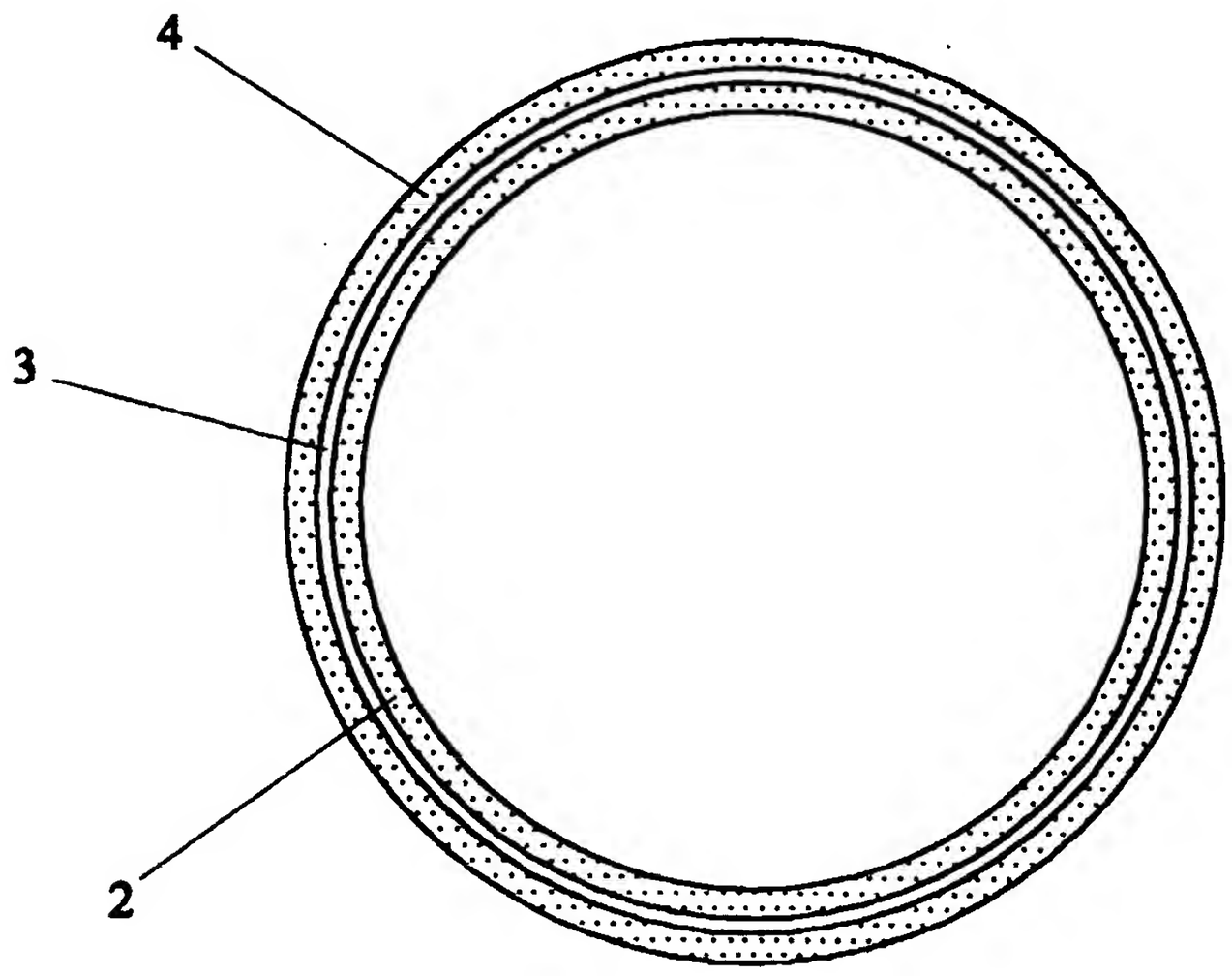

FIG. 2

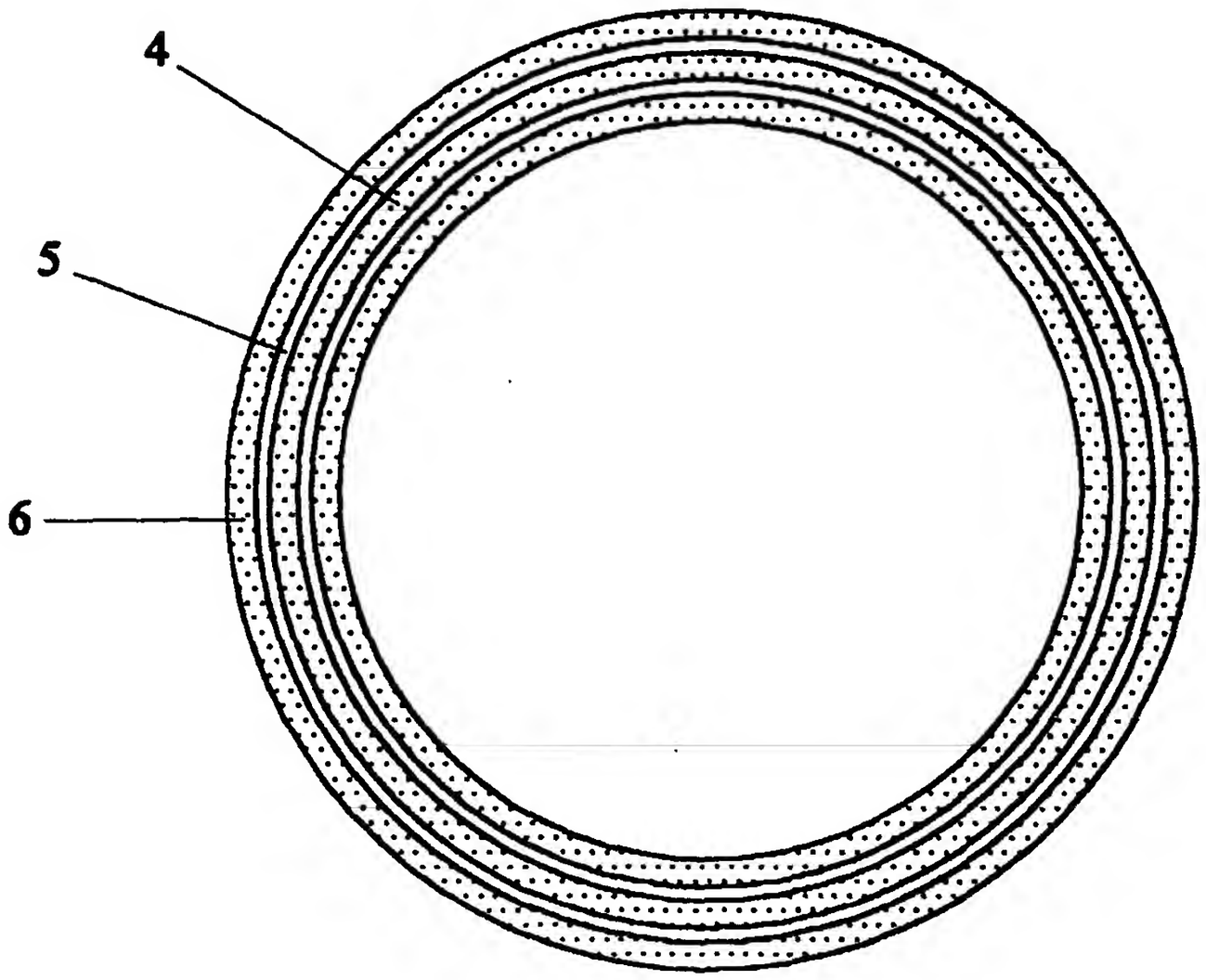

FIG. 3

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/GB 99/03214

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16L55/165

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 92 15818 A (WAVIN BV) 17 September 1992 (1992-09-17) page 7, line 1 -page 8, line 8 abstract; figures 1,2	1,12,13, 20
A	EP 0 270 347 A (HANDY & HARMAN) 8 June 1988 (1988-06-08) claims 3,4,6,9 abstract; figure 1	1,12,13, 20
A	US 4 861 634 A (RENAUD ALAIN S) 29 August 1989 (1989-08-29) abstract	1,12,13, 20

☐ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.

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information on patent family members

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